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Introduction

According to the 1987 population dynamics statistics compiled by the Ministry of Health and Welfare, the age-adjusted mortality of lung cancer in both men and women is the second highest (after stomach cancer) among cancer mortalities[1]. The age-adjusted mortality in stomach cancer has been steadily declining since 1960, while that of lung cancer has been rapidly increasing during the same period. If this trend continues, the ranking of these mortalities will be reversed by the year 2000[2].

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For risk factors to explain this rising incidence of lung cancer, smoking is cited first. In Japan, the incidence of smoking among men has been declining in recent years but it was reported to be 55% in 1988[3], a rate considerably higher in comparison to the incidences in the western world. Thus the promotion of an antismoking policy is considered to be necessary. Although the incidence of smoking has recently been increasing among young women, it was reported to be mere a 9%[3] in 1988, a figure much lower than those in western societies. To reflect this situation, the population-attributable risk of lung cancer due to smoking is 71% in men and only 26% in women[4]. In other words, it is suggested that risk factors other than smoking exist in the development of lung cancer among women.

In the past, for risk factors other than smoking that cause lung cancer to develop, studies have been conducted with a major focus on occupational exposure. In women, however, it is necessary that studies on exposure to various elements in the everyday environment supersede the investigation of the effects of occupational factors. However the relative risk of these elements in everyday environment is expected to be comparatively small. Thus it is necessary to include as many cases of lung cancer among nonsmoking women as possible for the analysis.

The purpose of the present study is to elucidate the risk factors of lung cancer among nonsmoking women. Therefore the status of passive smoking and the relationship between indoor air pollution and the development of lung cancer were investigated, using the data from the case-controlled studies conducted jointly by a number of health facilities. It should be noted that the study uses data collected up to the end of March 1989; thus the figures may be different in the final section of the report which is scheduled for the coming year.

1. Subjects and Method.

The "Organization to Eliminate Lung Cancer from Osaka"[3], with the participation of 8 major hospitals in Osaka specializing in the treatment of lung cancer, has been conducting a hospital-based case-controlled study since January 1986. Among the

patients newly admitted with a diagnosis of primary lung cancer, 658 men and 193 women were registered by the end of March 1989. Only 23 out of these 658 men (3.5%) were lifetime nonsmokers. Among the 193 female patients, however, 120 (62%) were nonsmokers. The present analysis was limited to these nonsmoking female patients. Of the lung cancers in these nonsmoking women, 78% were classified as adenocarcinoma.

For control, 519 nonsmoking female patients were selected from those newly admitted to the same hospitals with a diagnosis other than lung cancer. Neoplastic diseases were the predominant diagnosis (85%) of these patients. Breast cancer (240 cases) was the most common, followed by stomach cancer (63 cases). For the analysis, the ages criteria at the time of admission was set from 40 to 79 years for both the lung cancer patients and control.

The information on smoking and indoor air pollution was obtained from a questionnaire, filled out by the patients, which was distributed and collected at the time of admission. Any questionable responses concerning the present analysis were excluded from tabulation. Medical information such as histological type of cancer was obtained from attending physicians. The age-adjusted odds ratio and 95% confidence level were computed by the Mantel-Haenszel method using the PROC FREQ of SAS[6]. Factors with an estimated value of the odds ratio over 1.5 or below 0.67 were selected and subjected to a logistic regression analysis using PROC LOGIST of SAS[7].

2. Results

Table 1 shows an age-adjusted odds ratio where the population was divided into those with smoking husbands and other members of the family who were smokers. The table was prepared to find the effects of passive smoking on lung cancer in adults (prior to hospital admission). The odds ratio when the husbands were smokers was almost 1 (0.94), while smoking by other members in the household raised it to 1.45, indicating a slight increase in risk. Most of the other smoking members in a household were children.

To find the effects of passive smoking during early

childhood, the age-adjusted odds ratios were computed when fathers, mothers, or other members of the household were smokers. The results are shown in Table 2. When fathers were smokers, the odds ratio of passive smoking was 0.60, with a significant reduction in risk. When mothers were smokers, the odds ratio was computed to be 1.71. The risk rose in this instance but the change was not significant. The odds ratio for smoking by other members of the families was computed to be 1.13.

Table 3 shows the effects of using room heaters (which may be a cause of indoor air pollution) on the development of lung cancer as an age-adjusted odds ratio. The ratio was computed separately for each age category when the heater was in use. For heating facilities which may be the cause of indoor air pollution the following were included: unvented stoves using gasoline, gas, coal, charcoal briquettes, or wood; or a brazier, clay charcoal stove, or foot warmer which burns charcoal or briquettes. Air conditioners, stoves with vents, electric stoves, and electric foot warmers were excluded from the study. Odds ratios were computed in relation to the use of these sources of pollution at each age level when the heaters were used. As shown in Table 3, the ratios were near 1 for each age level, showing no significant relationship.

The effects of using foot warmers (burning charcoal, small briquettes, or round briquettes for the source of heat when sleeping) on the incidence of lung cancer were studied and expressed as an age-adjusted odds ratio in Table 4. These ratios, shown by age level, were near 1 for all ages, indicating no significant relationship.

Next, age-adjusted odds ratios were computed for the effects of using straw or wood for cooking on the development of lung cancer (Table 5). Again, the ratios were computed for each group. The ratio was 1.33 when the fuel was used at age 15 and 1.90 when used at age 30, with the latter showing a statistical significance. All the patients who had been using straw or wood for cooking at age 30 had also used the same fuel at age 15. Therefore the odds ratio computed at age 30 was interpreted to

express the effect of long-term exposure to this source of pollution. None of the patients was still using straw or wood as a source of cooking heat.

In these analyses, the odds ratios for the following 3 situations were computed to be over 1.5 or less than 0.67: smoking by father or mother when the patient was young and the use of straw or wood as the source of cooking heat at age 30. Using these 3 situations as variables, the odds ratio was estimated using a logistic regression model (Table 6). It was found that only the use of straw or wood as the source of cooking heat at age 30 showed a statistical significance.

3. Discussion

The results of the present study suggested that the use of straw or wood as a cooking fuel in the past is a risk factor in the development of lung cancer among nonsmoking women. Gao, et al.[9] investigated women in Shanghai and reported that the use of rapeseed oil raises the risk of lung cancer by 40%. In the same report, the use of cooking fuel (coal, city gas, and wood) did not increase the risk. Koo, et al.[8] conducted a study on women residing in Hong Kong and reported that among cooking fuels, the use of petroleum increases the risk of lung cancer while the risk is lower when propane gas (LPG) is used. However they added that these effects are relatively insignificant. MacLennan, et al.[10] conducted a study on Chinese women in Singapore and reported that there was no difference with respect to the risk of lung cancer when wood or charcoal used as cooking fuel was compared against petroleum and gas. The subjects of these studies were all Chinese women. In addition, exposure was based on whether the subjects ever used the fuel in question at all in the past or whether they are currently using it. Such criteria may not necessarily reflect past exposure accurately. Furthermore there is a possibility that those who were classified as "not exposed" may actually have been substantially exposed. If these possibilities are taken into consideration, the results of these studies do not necessarily contradict ours.

No subjects currently use straw or wood for cooking fuel so

we could not institute a policy of primary prevention of lung cancer in relation to this practice. However the finding is considered significant in suggesting that some factor(s) closely related to our daily lives may be recognized as risk factor(s) for lung cancer that appears 10 or 20 years later.

No statistical significance was obtained from the effect of maternal smoking when the subjects were young. However the estimated odds ratio was high (1.79) and the power to detect the significant difference from the cases of the present study was computed to be 56%. Therefore further studies with a larger number of subjects are considered necessary. As for the short-term effect of maternal smoking on the health of children, Tager, et al.[11] reported that the respiratory function was depressed in children when parents were smokers and the tendency was exaggerated when the mothers were smokers. Wu, et al.[12] conducted a case-controlled study on white women in Los Angeles but they failed to find a significant relationship between lung cancer and maternal smoking. In Japan, Shimizu, et al.[13] reported an odds ratio of 1.6 for maternal smoking in relation to lung cancer in women.

In the present study, the risk of lung cancer from paternal smoking was significantly reduced in a single variate analysis but the results of a multivariate analysis were not significant. Compared with the mother, the time a child spends with her father is expected to be short; and the tendency towards a decline in risk is believed to be due to some confounding factor (such as social class).

For the effect of passive smoking during adulthood, the present study focused on smoking by husbands but no significant correlation with lung cancer was established. In Japan, Hirayama[14], and Akiba, et al[15] found a significnat relationship between the two but Shimizu, et al.[13] did not. Blot, et al.[16] conducted a meta analysis based on epidemiological data throughout the world and estimated that husbands' smoking raises wives' risk for lung cancer by 30%. The 95% confidence range of the odds ratio in the present study is 0.62 to 1.40 and includes

1.30 within but a clearcut conclusion could not be drawn from such an uncertain risk factor. The present study also indicated that the effect of smoking by other members of the household, rather than by husbands, tends to be more significant. Shimizu, et al.[13] reported that smoking by fathers-in-law who lived in the same households has a more significant effect than that by husbands.

The analysis in the present study failed to show an increase in the risk of lung cancer in relation to the use of heating equipment. For the use of various heating devices, Leung[17] reported that the use of petroleum stoves raised the risk of lung cancer among women in Hong Kong. In Japan, however, Shimizu[18] conducted a case-controlled study in Nagoya in which no increase in the risk of lung cancer was recognized in association with the use of petroleum stoves.

The most serious problem inherent in the methodology of the present study is a large number of cancer patients (especially those with breast cancer) included in the control. Both the cases and control were nonsmokers and there have been no reports on the relationship between the exposure factor--the subject of the present analysis--and cancer involving other organs. Therefore inclusion of a large number of cancer patients is not considered to present a serious problem. However dominance by a single clinical entity (breast cancer in this instance) is not desirable in view of the nature of the control.

The authors plan further studies using a larger number of patients and an improved analysis of the control.

The authors express their gratitude to Dr. Hanai (Osaka Adult Disease Center) who prepared the original form of the questionnaire for the present survey under the guidance of Dr. Muir (IARC).

Table 1. Odds Ratio of Passive Smoking in Adulthood (before Hospitalization)

	Lung Cancer/Control	Odds Ratio* (95% Confidence Level)
Smoking by Husband		
no	56/229	1.00
yes	64/200	0.94(0.62-1.40)
Smoking by Other Members		
no	77/384	1.00
yes	43/135	1/45(0.94-2.23)

* Adjusted by age at hospital admission.

Table 2. Odds Ratio of Passive Smoking during Childhood

	Lung Cancer/Control	Odds Ratio* (95% Confidence Level)
Smoking by Father		
no	47/144	1.00
yes	73/375	0.60(0.40-0.91)
Smoking by Mother		
no	102/473	1.00
yes	18/46	1.71(0.95-3.10)
Smoking by Other Members		
no	95/416	1.00
yes	25/103	1.13(0.69-1.87)

* Adjusted by age at hospital admission.

Table 3. Odds Ratio When Heating Equipment Which May Be The Cause of Indoor Air Pollution Is Used--Observation in Relation to the Age When the Equipment Was Used

Use of Equipment	Lung Cancer/Control	Odds Ratio* (95% Confidence Level)
At Age 15		
not used	37/150	1.00
used	83/369	0.94(0.60-1.45)
At Age 30		
not used	45/212	1.00
used	75/307	1.09(0.72-1.65)
At Present		
not used	65/289	1.00
used	55/230	1.07(0.71-1.60)

* Adjusted by age at admission.

Table 4. Odds Ratio When Foot Warmers Were Used During Sleep--Observation at Each Age Level

Use of the Equipment	Lung Cancer/control	Odds Ratio* (95% Confidence Level)
At Age 15		
not used	76/327	1.00
used	44/192	0.97(0.64-1.47)
At Age 30		
not used	95/429	1.00
used	25/90	0.89(0.53-1.51)
At Present		
not used	119/514	1.00
used	1/5	0.67(0.09-4.99)

* Adjusted by age at hospital admission.

Table 5. Odds Ratio When Straw and Wood Are Used for Cooking Fuel

Use of the Fuel	Lung Cancer/Control	Odds Ratio* (95% Confidence Level)
At Age 15		
not used	46/252	1.00
used	74/267	1.33(0.87-2.02)
At Age 30		
not used	94/469	1.00
used	26/ 50	1.90(1.09-3.30)
At Present		
not used	123/519	-
used	0/0	-

* Adjusted by age at hospital admission.

Table 6. Age-Adjusted Odds Ratios for Maternal and Paternal Smoking during Childhood; and the Use of Straw and Wood as a Cooking Fuel at Age 30, Calculated by Logistic Regression Analysis

Factors	Odds Ratios (95% Confidence Level)
Maternal Smoking During Childhood	1.82(0.98 - 3.37)
Paternal Smoking During Childhood	0.70(0.43 - 1.16)
Use of Straw and Wood as Cooking Fuel at Age 30	1.78(1.02 - 3.10)

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